REMARKS

Upon entering the above amendment, claims 1-17 and 29-32 will be pending in this application and are presented for examination. Claims 1-17 and 29-31 stand rejected. Claim 1 has been amended. Claim 32 is newly added.

Reconsideration of the application is respectfully requested in view of the above amendments to the claims and the following remarks. For the Examiner's convenience and reference, Applicants' remarks are presented in the order in which the corresponding issues were raised in the Office Action.

The amendment to claim 1 finds support throughout the specification, but particularly at page 5, lines 16-17: "aligned conductive region, such as an aligned conductive material or particle." Further support is found at page 6, line 22 to page 7, line 10, as well as at page 8, line 27 to page 9, line 8. New claim 32 finds support in claim 1 and 31.[1]

Applicants believe no new matter is present in this or any other portion of the present amendment.

I. The Instant Invention

The instant invention relates to sensor arrays that are able to mimic chemical sensing, *i.e.* electronic noses. These sensors are applicable to a wide variety of applications, including environmental and quality control, biomedicine, emissions control, gas detection, illegal substance detection, infectious disease detection, etc. Advantageously, the sensors of the present invention enhance the signal-to-noise ratio (S/N) of the sensor element. By increasing the S/N of a sensor element, a lower detection limit is possible (*i.e.*, the lower the concentration of analyte it is possible to detect).

The present invention provides a sensor having an aligned conductive region that results in a reduced percolation threshold. The aligned conductive region comprises an aligned

[1] As new claim 32 has not previously been examined, Applicants respectfully submit that it would be improper to make final the first Office Action following an RCE. (MPEP § 706.07(b))

conductive material which is further comprised of aligned particles. Reduced percolation thresholds mean that a slight swelling of the composite sensor can result in a very large change, in for example, the resistance. In a preferred embodiment, the aligned conductive region produces a stable base resistance and thereby enhances the signal-to-noise ratio while maintaining low volume loadings.

II. Rejection under 35 U.S.C. § 102(b) in view of Debe *et al.*

The Examiner has maintained the rejection of claims 1-7, 9-15, 17 and 29-31 under 35 U.S.C. § 102(b) as allegedly being anticipated by Debe *et al.* (U.S. Patent No. 5,238,729). To the extent the rejection is applicable to the amended set of claims, Applicants respectfully traverse the rejection.

A. Whiskers are not particles

For the Examiner's convenience, amended claim 1 reads as follows:

> A sensor array for detecting an analyte in a fluid, said sensor array comprising: first and second sensors wherein said first sensor comprises a sensing region of an aligned conductive material and a nonconductive region, each of which sensors provides a different detected response in the presence of said analyte; **wherein said aligned conductive material comprises aligned distinct particles;** wherein said sensor array is electrically connected to a computer comprising a resident algorithm; the computer detecting said response and comparing said response to a known sensor array response profile.

Particles useful in the present invention are set forth at page 6, line 22 to page 7, line 12, and include metals, metal oxides, carbon black, coke, C_{60}, polymers, nanoparticles and organometallics, among others. One of skill in the art will appreciate that the particles described above are on the nanoscopic scale (10^{-9} m), being about 1 to several tens of nanometers in size.

The Examiner alleges, however, that Debe *et al.* teaches the whisker-like structures as the nanoparticles of the present invention at column 9, lines 1-3. For the Examiner's convenience, column 9, lines 1-3 of Debe *et al.* sets forth the following:

> Preferably, the **wall thickness of the conformal coating** surrounding the whisker-like structure is in the[*sic*] from about 0.5 nanometers to about 30 nanometers. (Emphasis added)

As the Examiner can see, Debe *et al.* is describing the thickness of the **conformal coating** that coats the whiskers, not the size of the whiskers themselves. Debe *et al.* describes the preferred dimensions of the whisker-like structures at column 8, lines 29-35:

> The whisker-like structures are typically uniform in size and shape, and have uniform cross-sectional dimensions along their major axes. The preferred length of each structure is in the range of **0.1 to 2.5 micrometers**, more preferably in the range of 0.5 to 1.5 micrometers. The diameter of each structure is preferably less than 0.1 micrometer. (Emphasis added)

In addition, Example 1 of Debe *et al.* teaches oriented crystalline whiskers of 1-2 μm in length. Clearly, the preferred size of the discrete, oriented structures of Debe *et al.* is several micrometers in length and at least about 0.1 μm in diameter. In stark contrast to Debe *et al.*, the particles used in the sensors of the present invention are only a few nanometers in size. As Debe *et al.* fails to teach or suggest the particles of the present invention, Applicants respectfully submit that Debe *et al.* does not anticipate the claims of the present invention. Accordingly, Applicants respectfully request that the rejection be withdrawn.

B. Orientation of the conductive particles

In addition to being smaller (*e.g.*, about 100-1000 times) than the whiskers of Debe *et al.*, the particles of the present invention are also aligned in a wholly different process. Alignment, as used in the instant invention, does **not** refer to the physical, macroscopic orientation of the individual conductive materials, but rather to the electrical, thermal, magnetic, electromagnetic, photoelectric, mechanical, etc., alignment of the discrete particles that make-up the conductive material as a whole. The appropriate methods for carrying out the alignment of the conductive material are set forth at page 6, lines 15-21:

> The alignment of the conductive region, *e.g.*, material or particles, is effected through the application of various processing techniques. For instance, polarization techniques can be used to align the conducting region. Suitable polarization techniques include, but are not limited to, exposure to an electric field, a thermal field, a magnetic field, an electromagnetic field, a photoelectric field, a light field, a mechanical field or combinations thereof. The techniques employed to align the particles depends in part on the particle composition.

The orientation of the particles of the present invention is not set until after the device has been prepared. Furthermore, the direction of the orientation is tunable, that is it can be set in any desired direction relative to the surface of the conductive material.

In contrast to the present invention, the orientation of the microstructures of Debe *et al.* is determined during the preparation of the microstructures and is fixed, see Example 1 at column 12. As set forth in Example 1, the whisker-like structures of Debe *et al.* are prepared via vapor deposition of perylene red onto a film of polyimide, followed by heating and vacuum annealing to afford the crystalline whiskers "1 to 2 μm in length." As the perylene red layer is annealed, the whisker-like structures crystallize into structures oriented perpendicular to the polyimide surface (see Fig. 1). As the orientation of the microstructures is set during preparation, the orientation is fixed and static, not tunable, as the orientation of the particles of the instant invention are.

As Debe *et al.* teaches only a physical orientation of the whiskers, Applicants submit that Debe *et al.* does not teach or suggest the thermal, electrical, magnetic, etc., alignments of the present invention. There is no discussion whatsoever in Debe *et al.* about how to "align" the discrete components of the whisker-like structures or of the conformal coatings. There is only a discussion about the preferred macroscopic physical orientation of the whisker-like structures to the substrate and to one another.

It is the alignment of the nanoscopic particles of the present invention that provides the vastly improved sensitivity in comparison to the prior art. In this regard, the Examiner's attention is respectfully directed to page 6, lines 3-10 of the specification:

> The sensors of the present invention have an aligned conductive region that results in reduced percolation thresholds. Reduced percolation thresholds mean that a slight swelling of the composite sensor can result is[*sic*] a very large change in resistance. This is because the few conductive particles are all participating in the connected paths, and any discontinuity in the connectivity results in a large resistance change. Thus, *the alignment of the conductive region results in all of the particles participating in the connected electrical paths. By aligning the conductive region, these systems will produce a stable base resistance and thereby enhance the signal-to-noise ratio.* (Emphasis added).

Clearly, the reduced percolation threshold of the sensors of the present invention provides the sensors with a greatly improved signal-to-noise ratio. This improved signal-to-noise ratio is a direct result of using the nanoscopic particles with a tunable alignment. The Examiner's attention is respectfully directed to page 5, lines 7-10 of the current specification:

> Surprisingly, it has now been discovered that by intentionally aligning the conductive region, there is an increase in the detection limit, *i.e.*, the sensor is capable of detecting lower concentrations of analyte;

and page 5, line 31 to page 6, line 2:

> Before the advent of the present invention, the noise level associated with such low volume loadings was prohibitively high. However, by aligning the conductive region, lower volume loadings can now be used. Moreover, by aligning the conductive region, the percolation threshold is easier to obtain at low volume loadings.

In addition, Example 1 of the present invention, demonstrates the lower percolation threshold when using an aligned conductive material, see Figures 1 and 2. Figure 2 shows the resistance versus volume curve using an aligned conductive material. This material demonstrates a 75% decrease in the percolation threshold compared to the non-aligned conductive material shown in Figure 1.

In view of the above, Applicants submit that the Examiner has inappropriately applied the use of the term "align", as it relates to the instant application, to Debe *et al.* As used in the instant application, "align" refers to the electrical, thermal, magnetic, electromagnetic, photoelectric, mechanical, etc., alignment of the discrete particles that make-up the conductive material as a whole. In contrast, Debe *et al.* teaches only the physical macroscopic orientation of the whisker-like structures in relation to the substrate and to one another. In addition, Debe *et al.* fails to teach the particles taught and claimed in the instant application. As such, Applicants submit that Debe *et al.* fails to teach or suggest the claimed invention. Accordingly, Applicants respectfully request that the rejection be withdrawn.

III. Rejection under 35 U.S.C. § 103(a) in view of Debe *et al.* in combination with Lewis *et al.*

The Examiner has further maintained the rejections of claims 8 and 16 under 35 U.S.C. § 103(a) as allegedly being obvious in view of Debe *et al.* in combination with Lewis *et al.* (WO 99/00663). In response, Applicants respectfully traverse the rejection.

The Examiner alleges that "the claimed invention is disclosed as noted above except the particular metal oxides." Applicants respectfully disagree. As discussed above in Section II, Debe *et al.* fails to teach or suggest an important feature of the instant invention: the aligned particles of the present invention.

Furthermore, Lewis *et al.* teaches only a combinatorial approach for preparing arrays of chemically sensitive polymer-based sensors for the detection of analytes in a fluid. Accordingly, Applicants state that there is simply no motivation or suggestion provided in the cited references to modify their teachings in the way the Examiner has contemplated. Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

As there is no suggestion or motivation in Debe *et al.* or Lewis *et al.* to align the discrete components of the conductive material, Applicants submit that it would not have been obvious to start with the inventions of Debe *et al.* and Lewis *et al.*, and arrive at the present invention. Accordingly, Applicants respectfully request that the rejection be withdrawn.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance and an action to that end is urged.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 925-472-5000.

Respectfully submitted,

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